Imaging Choices in the Management of Colorectal Cancer

Part 1

Patrick Vos
Department of Radiology
St. Paul’s Hospital
Vancouver, BC
Imaging Choices in the Management of Colorectal Ca

Review staging Colorectal Ca
Local staging
Lung and liver lesions

PART 2: PET/CT  Dr. Pete Tonseth
No time

Colon Ca
Details local Rectal staging
New Imaging Techniques (MR)
Tumor regression post Ch/RT
Local Staging Rectal Cancer

Kaur H et al. Radiographics 2012;32:389-409
Rectal Ca
Local Staging

Accuracy DRE T staging 58-88%

EUS Staging information changed the surgeon’s original treatment plan based on CT in 31% of patients

Harewood GC. Gastroenterology 2002; 123:24-32
A) Tumor Staging

- **“Good”**
  - T1,2,3N0
  - No poor prognostic features
  - No threat to sphincter preservation
  - No RT/CRT

- **“Bad”**
  - T3c/d mid/upper rectum
  - Limited or low risk involved LN’s
  - Little challenge to sphincter preservation
  - Short Course CRT

- **“Ugly”**
  - Threatened CRN
  - Poor prognostic features
  - Challenged sphincter preservation
  - Long Course CRT

  - **Radical TME**

B) Tumor Staging

- Long Course CRT

  - Restaging

  - **“Good”**
    - Clinical Complete Response
    - Watch & Wait

  - **“Bad”**
    - Clinical Near Complete Response
    - Local Excision

  - **“Ugly”**
    - Clinical Poor Response
    - Radical TME
Clinical Stage 1 (T1, T2, N0, M0)
- Segmental resection. No preop radiation
- Local excision if favorable T1 lesion

Clinical Stage 2 (T3, T4, N0, M0)
- Preop short course radiation
- Segmental resection. Local excision contraindicated

Clinical Stage 3 (any T, N1, N2, N3, M0)
- Managed as for stage 2
- Preop radical preoperative chemoradiation may be indicated

Clinical Stage 4 (any T, any N, M1)
- Excision of primary tumor
- Chemoradiation
- Resection of metastatic lesion
- Fulguration/laser/ endoluminal radiation
• Complete colonoscopy
• Tumour height
• Accurate preoperative staging

• Preoperative CEA
• PET scan not recommended
• Core biopsy in patients with unresectable disease
Accurate preoperative staging

- Location (height)
- TNM staging
- Free resection Margin TME
Tumor Location

- Surgical planning
- Determine pre-op management
- Most distal location of the tumour is used to define tumour location
Tumour Height Measurement

Decreasing order of reliability???

1. Rigid sigmoidoscopy
2. Flexible sigmoidoscopy/colonoscopy
3. Endorectal ultrasound (can overestimate)
4. DRE (low lying tumours)
5. CT or MRI
Relationship to anal sphincter

Kaur H et al. Radiographics 2012;32:389-409
Best imaging modality determined by T Stage
Endorectal Ultrasound

Rectal Cancer

Advantage:
High Spatial Resolution
Differentiate T0-T1-T2-T3
In office
T3 rectal cancer
ERUS Disadvantage:

Availability/Expertise
High/low/obstructing tumors
Discomfort
Cannot see MRF
May overestimate distance
Overstaging: 20% T3-T4 actually T2

T Stage?
T2
Transverse ERUS invading muscularis propria
Perirectal tissue is clear
**uT3:**

- Tumor penetrates the entire thickness of the bowel wall and invades the perirectal tissues
## ERUS T0-T1

<table>
<thead>
<tr>
<th>Meta analysis</th>
<th>Sens</th>
<th>Spec</th>
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</thead>
<tbody>
<tr>
<td><strong>Tis</strong></td>
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<tr>
<td>Puli (<em>Dig Dis Sci</em> 10)</td>
<td>97</td>
<td>96</td>
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<tr>
<td><strong>T1</strong></td>
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<td></td>
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<tr>
<td>Bipat (<em>Radiology</em> 04)</td>
<td>94</td>
<td>86</td>
</tr>
<tr>
<td>Puli (<em>Ann S Onc</em> 09)</td>
<td>88</td>
<td>98</td>
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</table>
Rectal Ca

MRI

T0 TEM
T1 TEM
T2 TME
T3 Rth
T4 Ch-Rt
MRI advantage:

- High Spatial Resolution
- More available ERUS?
- Best Method to see MRF

MRI advantage:

• Reliable and reproducible technique with high specificity (92%) for:
  – relationship to the MRF
  – Depth tumor invasion outside muscularis propria

MRI

Disadvantage:

• Availability
• Claustrophobia etc
• No staging outside pelvis

Muthusamy VR, Chang KJ. Clin Cancer Res. 2007
MRI
Disadvantage:

- Expertise
- Interobserver variability
- Need High Resolution Images

- Limitations borderline T2-T3
- Overstaging T2  29-40%

<table>
<thead>
<tr>
<th>Modality</th>
<th>Sens</th>
<th>Spec</th>
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<tbody>
<tr>
<td>MRI</td>
<td>94/82%</td>
<td>70/75%</td>
</tr>
<tr>
<td>ERUS</td>
<td>94/90%</td>
<td>85/75%</td>
</tr>
</tbody>
</table>

Bipat et al. Radiology 2004
Rectal Ca

T0
TEM

T1
TEM

T2
TME

T3
Rth

T4
Ch-Rt

MRI = CT
CT advantage:

- Fast
- Available
- Staging entire chest/abd/pelvis
Mesorectal Fascia
CT
## CT Accuracy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Stage $\leq$ T2 (pT1, $n = 3$; pT2, $n = 10$)</th>
<th>Stage T3 (pT3, $n = 25$)</th>
<th>Stage T4 (pT4, $n = 3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transverse Images Alone</td>
<td>Transverse and MPR Images Combined</td>
<td>Transverse Images Alone</td>
</tr>
<tr>
<td>Accuracy</td>
<td>90</td>
<td>93</td>
<td>85</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>82</td>
<td>92</td>
<td>76</td>
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<tr>
<td>Specificity</td>
<td>93</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>82</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>93</td>
<td>96</td>
<td>73</td>
</tr>
</tbody>
</table>
CT disadvantage:

- Less detailed spatial and contrast resolution

Accuracy
advanced T3-T4  79% to 94%
All stages  52% to 74%

Muthusamy VR. Clin Cancer Res. 2007
T Stage?
T4 Lesions

Loss of fat plane between tumor and lower uterine segment  Sacral invasion
Nodes
N = Regional Lymph Nodes

- NX: Regional lymph nodes cannot be assessed
- N0: No regional lymph node metastasis
- N1: Metastasis in 1 to 3 regional lymph nodes
- N2: Metastasis in 4 or more regional lymph nodes
- N3: Metastasis in a lymph node along the course of a named vascular trunk
N = Regional Lymph Nodes

Distribution depends on level of tumor:

Upper Rectum
- epicolic nodes → pararectal nodes → intermediate mesocolic nodes → principle IMA nodes

Lower Rectum
- middle and inferior rectal vessels → hypogastric and obturator nodes → paraaortic nodes
common nodal pathways of tumor spread

Kaur H et al. Radiographics 2012;32:389-409

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Nodal Criteria for Size?
N = Regional Lymph Nodes
### Nodal Criteria for Size

<table>
<thead>
<tr>
<th>Node</th>
<th>Size</th>
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<tbody>
<tr>
<td>Retroperitoneal</td>
<td>10 mm</td>
</tr>
<tr>
<td>Mesenteric</td>
<td>10 mm</td>
</tr>
<tr>
<td>Common Iliac</td>
<td>9 mm</td>
</tr>
<tr>
<td>External Iliac</td>
<td>10 mm</td>
</tr>
<tr>
<td>Internal Iliac</td>
<td>7 mm</td>
</tr>
<tr>
<td>Obturator</td>
<td>8 mm</td>
</tr>
<tr>
<td>Superior Rectal</td>
<td>5 mm</td>
</tr>
<tr>
<td>Pararectal</td>
<td>3 mm</td>
</tr>
<tr>
<td>Deep/Superficial Inguinal</td>
<td>10 mm</td>
</tr>
<tr>
<td>Lateral Sacral</td>
<td>7 mm</td>
</tr>
</tbody>
</table>
Nodal spread and micrometastasis within mesorectum

- 31 consecutive patients
- No chemo/radiation
- 21 T3
- 992 lymph nodes harvested
- metastasis found in 148 nodes

Wang C et al. World J Gastroenterol 2005 June 21
Nodal spread and micrometastasis within mesorectum

- <1mm: 7%
- <2mm: 24%
- <5mm: 70%

Wang C et al. World J Gastroenterol 2005 June 21
## Nodes

### Size criteria

<table>
<thead>
<tr>
<th>Size</th>
<th>Sens</th>
<th>Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>3mm</td>
<td>78</td>
<td>59</td>
</tr>
<tr>
<td>10mm</td>
<td>3%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Brown G. Br J Surg. 2003;90*
N=188
EUS/MR staged T3 N0

- Multicenter
- 188 pts
- T3 N0 ERUS/MRI
- preop Ch-RT

Guillem JG. J Clin Oncol. 2008 Jan 20
N=188
EUS/MR staged T3 N0

• 22% of patients undetected mesorectal LN involvement despite Ch-RT

Guillem JG. J Clin Oncol. 2008 Jan 20
Nodal spread

Overall accuracy 60-80%
No differences ERUS/MR/CT

T stage correlates with LN positivity
T stage correlates with accuracy LN staging

Wang C et al. World J Gastroenterol 2005 June 21
Other criteria

<table>
<thead>
<tr>
<th></th>
<th>sens</th>
<th>spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount not helpful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiculated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indistinct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>85%</td>
<td>98%</td>
</tr>
</tbody>
</table>

**Kim JH. Eur J Radiol. 2004 Oct;52(1):78-83.**
Irregular Border and Mixed Signal Intensity
Reliability of imaging modalities for predicting lymph node involvement uncertain

Up to 20% of patients have involved nodes of less than 3mm
N + = 100% positive

Enlarged pararectal nodes  Enlarged left paraaortic node

Kim JH. Eur J Radiol. Oct 2004;52
Conclusion

T stage assessment is fairly accurate

N stage is only moderately effective whatever modality is used
Conclusion

• New techniques
  – DWI
  – Specific contrast agents
  – USPIO, Gadofosveset
  – PET/CT  PET/MR ??
M = Distant Metastases

MX = Distant metastases cannot be assessed

M0 = No distant metastases

M1 = Distant metastases
Distant Metastases

Enlarged portocaval node

Liver metastasis
Distant disease and Follow-up

• Generally CT sufficient
• Follow-up: How often? How long?

• What to do with incidental findings?
  – Liver: subcentimeter lesions TSTC
  – Lung: small nodules ILN
What to do with incidental findings?

- Liver: TSTC
- Lung: ILN
Prevalence and importance of small hepatic lesions found at CT in patients with cancer

- CT 2,978 patients with cancer
- Benign: 303/2978 (80.2%) patients
- Malignant 44 (11.6%) patients
- Indeterminate 31 (8.2%) (short FU)
- CRC: mets in 14% pts with CRC

Prevalence and importance of small hepatic lesions found at CT in patients with cancer

• CONCLUSION:

• small hepatic lesions in patients with cancer majority is benign

• metastases in 14 % of patient

Natural history of small, "indeterminate" hepatic lesions in patients with colorectal cancer

- 70/419 patients (16.7%) small liver lesions TSTC
- 46 patients (65.7%) subsequent imaging of their liver lesions
- 41 (89.1%) stable likely benign
- 5 (10.9%) progression suggestive of mets

Lim GH. Dis Colon Rectum. 2009 Aug;52(8)
CT follow-up hypoattenuating small liver lesions in patients with rectal ca

- 616 consecutive patients
- 70 patients with 163 hepatic lesions
- Patients stable 80%
- Lesions Stable 90.8%

- No significant difference in results was found for patients stratified according to T-stage

*Tan CH. Am J Clin Oncol. 2011 Aug;34(4)*
CT follow-up hypoattenuating small liver lesions in patients with rectal ca

• CONCLUSION

• majority of small hypoattenuating liver lesions remain stable and treated as benign lesions

• Closely followed for at least 1 year after completion of therapy

Tan CH. Am J Clin Oncol. 2011 Aug;34(4)
CECT

- retrospective study breast ca
- 1012 woman CT
- 277 pts TSTC but no definite liver metastases at initial CT
- 92.7%-96.9% the lesions represented a benign finding

Problem solving

- **US**: small cysts
- **MRI**: hepatocyte-specific contrast agents
  Gd-EOB-DTPA (Primovist)
- **Follow-up**
<table>
<thead>
<tr>
<th></th>
<th>CECT</th>
<th>MRI</th>
<th>PET</th>
<th>PET-CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sens per lesion</td>
<td>69-79%</td>
<td>75-85%</td>
<td>67-91%</td>
<td>55-75%</td>
</tr>
<tr>
<td>Spec per patient</td>
<td>93-96%</td>
<td>90-95%</td>
<td>93-98%</td>
<td>93-99%</td>
</tr>
</tbody>
</table>

*Frankel et al. J Gastrointest Oncol. 2012*
*Niekel et al. Radiology. 2010 Dec*
Screening studies, up to 51% of smokers aged 50 years or older have pulmonary nodules on CT scans
CT staging of colorectal cancer: what do you find in the chest?

- 568 CRC complete CT staging
- 31 (6%) had lung metastases
- 353 (68.7%) no evidence of metastases
- 130 (25.3%) had indeterminate lung nodules
  - 12 patients subsequently confirmed as mets
- 3% major non-metastatic finding (PE, Lung Ca)

McQueen, Clin Radiol. 2012 Apr;67(4)
CT staging of colorectal cancer: what do you find in the chest?

CONCLUSIONS:

1. Thoracic CT altered initial TNM stage in fewer than 1% of CRC patients

2. Detection of significant incidental chest disease and the establishment of an imaging baseline are useful outcomes of this imaging strategy

3. Staging examinations 25% ILNs

McQueen, Clin Radiol. 2012 Apr;67(4)
Pulmonary staging in colorectal cancer: a review

• A review of studies assessing chest staging modalities for patients with CRC
  • Majority were case series
  • Low pick-up rate for CXR
  • Increased detection rates chest CT

Rectal ca: incidence lung mets 10%-18%
Colon cancer: incidence lung mets 5-6%

Clinical benefit of increased detection rates not clear
Incidence ILN 4%-42%

 Majority (≥ 70%) of ILN’s did not have any clinical significance

*Parnaby CN. Colorectal Dis. 2012 Jun;14(6):660-70*
Pulmonary staging in colorectal cancer: a review

Incidence of synchronous liver and pulmonary metastases 45% to 70%

No evidence superiority of PET/CT vs CT for the detection of pulmonary metastases or characterization of ILL

CONCLUSION:

• CT scanning increases the detection rates for ILL and pulmonary metastases

• Clinical benefit increased detection rates not clear

• Paucity of data optimal chest staging strategy

Summary

• Best choice Imaging depends on T stage
Suggestions: Imaging Strategy

Clinical CT

- T0-T1
- ERUS
- T1-T2-T3
- ERUS-MRI
- T3-T4
- MRI?
Summary

- Imaging often complimentary
- Overstaging: ERUS + MRI
- Accuracy LN 60-80%
Summary

• Have a plan:
  – Liver: TSTC
  – Lung: ILN’s

• Clinical benefit of increased detection rates not clear
Summary

• Standardized/Template reporting?
APPENDIX A: MRI SYNOPSIS REPORT

1. MRI PROTOCOL
   Overall image quality:  [ ] Adequate  [ ] Suboptimal  [ ] Non-diagnostic

2. TUMOUR LOCATION
   Tumour location (from anal verge):  [ ] Low (0-5.0 cm)
   [ ] Mid (5.1-10.0 cm)
   [ ] High (10.1-15.0 cm)

   Distance of the lowest extent of tumour from anal verge:  [ ] cm
   Distance of lowest extent of tumour from top of the anal sphincter:  [ ] cm
   Relationship to anterior peritoneal reflection:  [ ] Above  [ ] At or straddles  [ ] Below  [ ] Not able to assess

3. TUMOUR CHARACTERISTICS
   Circumferential extent/location (clock face):  [ ] cm
   Mucinous:  [ ] No  [ ] Yes

4. T-CATEGORY
   i) T-category:
      [ ] T1 or T2
      [ ] T2/early T3 (includes spiculation of the perirectal fat)
      [ ] T3
      [ ] T3/possible T4*
      [ ] T4*

      *Please indicate structures with possible invasion:  [ ] (see list below)

      | GU  | PEVIC SIDE WALL | BONE/VASCULAR | OTHER  |
      |-----|----------------|---------------|--------|
      | bladder; left ureter; right ureter; prostate | obturator internus | sacrum (specify level) | anterior peritoneal reflection |
      | vagina | piriormis | left internal iliac vessels; right internal iliac vessels | left external iliac vessels; right external iliac vessels |
      | levator ani | pubococcygeus, ischioleucoccygeus | coccygeus |

   ii. For low rectal tumours (0-5 cm) only:
      Is the lower extent of the tumour at or below the top border of the puborectalis?  [ ] No  [ ] Yes*
      *If yes, please complete the following section for the most penetrating component of the tumour below the top border of puborectalis:

      [ ] Possible confinement to the submucosa; no definite involvement of internal sphincter (suspected T1)
      [ ] Confined to the internal sphincter: no involvement of intersphincteric fat or external sphincter (early T2)
      [ ] Through the internal sphincter and intersphincteric fat: possible or definite involvement of the external sphincter (advanced T2)
      [ ] Through the external sphincter and into surrounding soft tissue; no organ involvement (T3)
      [ ] Through external sphincter and possible involvement of the adjacent organs [i.e., prostate, vagina] (T3/T4)
      [ ] Through external sphincter and definite involvement of adjacent organs [i.e., prostate, vagina] (T4)
5. **DISTANCE TO THE MRF AND EXTRAMURAL DEPTH OF INVASION (EMD)**

   i) Shortest distance of the definitive tumour border to the MRF = ________ mm
      [or □ unable to estimate or □ not applicable (involving the peritonealized portion of the rectum or T4a)]

   ii) Extramural depth of invasion (EMD) at this level = ________ mm
       [Record 0 mm for T1 and T2 tumours]

   iii) Are there any tumour spiculations closer to the MRF? □ No □ Yes*

       *If yes, please specify distance = ________ mm and location ___________________________ (on clock face)

   iv) Is there any other component of the tumour (any T1-3) closer to the MRF? □ No □ Yes*

       *If yes, please specify distance = ________ mm and location ___________________________ (on clock face)

6. **EXTRAMURAL VASCULAR INVASION (EMVI)**

   EMVI: □ Absent □ Equivocal □ Present

7. **MESORECTAL LYMPH NODES AND TUMOUR DEPOSITS**

   Any suspicious mesorectal lymph nodes and/or tumour deposits? □ No □ Yes*
   (suspicious = irregular border, mixed signal intensity and/or ≥ 8 mm)

   *If yes: (please complete a and b)
Stage?
The end